

CLAIMS

1. A method for distributed agent based non-expert simulation of manufacturing process behavior on a single-processor computer comprising the steps of:
object modeling a manufacturing technique having a plurality of processes;
associating a distributed agent with each said process; and,
programming each said agent to respond to discrete events corresponding to said manufacturing technique, wherein each said discrete event triggers a programmed response.

2. The method according to claim 1, further comprising the step of transmitting said discrete events to each said agent in a message loop.

3. The method according to claim 1, wherein the programming step comprises the step of conditioning each said agent to respond to a discrete event selected from the group consisting of a clock tick message, a resources received message, and a request for output production message.

4. The method according to claim 3, wherein the programming step further comprises the steps of:

in response to said clock tick message, programming each said agent to place finished output in an output stack corresponding to said associated process;

in response to said resources received message, programming each said agent to initiate production of output using resources contained in an input stack corresponding to said associated process; and,

programming each said agent to pass to an agent associated with an upstream process any output in said output stack produced in response to said discrete event.

1 5. The method according to claim 3, wherein the programming step further
2 comprises the steps of:

3 in response to said clock tick message, programming each said agent to
4 place finished output in an output stack corresponding to said associated process;

5 in response to said resources received message, programming each said
6 agent to inspect an input stack corresponding to said associated process, and to
7 initiate production of output if said input stack has resources adequate to
8 completely produce an output unit;

9 in response to said request for output production message, programming
10 each said agent to inspect an output stack corresponding to said associated
11 process for adequate output to satisfy said output production request, to inspect an
12 input stack corresponding to said associated process only if said output stack lacks
13 adequate output to satisfy said output production request, to initiate production of
14 output if said input stack has resources adequate to completely produce output
15 sufficient to satisfy said output request, and to post a request for output production
16 message to an agent associated with a downstream process if said input stack
17 lacks adequate resources to satisfy said output production request; and,

18 programming each said agent to pass to an agent associated with an
19 upstream process any output in said output stack produced in response to said
20 discrete event.

1 6. The method according to claim 4, wherein the programming step further
2 comprises the steps of:

3 setting a minimum output level of output in an output stack corresponding to
4 a process; and,

5 programming each said agent to produce replacement output in response to
6 said output falling below said minimum output level.

1 7. The method according to claim 3, wherein the programming step further
2 comprises the steps of:

3 in response to said clock tick message, programming each said agent to
4 compare said clock tick message with a pre-specified takt time corresponding to
5 said associated process; and,

6 in response to a clock tick message correlating to said pre-specified takt
7 time, programming each said agent to place completed output in an output stack
8 corresponding to said associated process, to retrieve resources contained in an
9 input stack corresponding to said associated process, to initiate production of
10 output using resources contained in said input stack, and to pass to an agent
11 associated with an upstream process any output in said output stack.

12 8. A method for distributed agent-based simulation of manufacturing process
13 behavior, the simulation having a plurality of agents corresponding to individual
14 processes forming a manufacturing technique, the method comprising the steps of:

15 receiving a message from an agent;

16 identifying in said received message a discrete event selected from the group
17 consisting of a clock tick event, a resources received event, and a request for
18 output production event;

19 causing an associated process to perform an activity in response to said
20 identified event; and,

21 messaging an adjacent agent in response to said identified event.

22 9. The method according to claim 8, wherein said causing step comprises the
23 steps of:

24 in response to said clock tick event, placing finished output in an output
25 stack corresponding to said associated process;

26 in response to said resources received event, initiating production of output

6 using resources contained in an input stack corresponding to said associated
7 process; and,

8 passing to an agent associated with an upstream process any output in said
9 output stack produced in response to said discrete event.

1 10. The method according to claim 8, wherein said causing step comprises the
2 steps of:

3 in response to said clock tick event, placing finished output in an output
4 stack corresponding to said associated process;

5 in response to said resources received event, inspecting an input stack
6 corresponding to said associated process, and initiating production of output if said
input stack has resources adequate to completely produce an output unit;

7 in response to said request for output production event, inspecting an output
8 stack corresponding to said associated process for adequate output to satisfy said
9 output production request, inspecting an input stack corresponding to said
10 associated process only if said output stack lacks adequate output to satisfy said
11 output production request, initiating production of output if said input stack has
12 resources adequate to completely produce output sufficient to satisfy said output
13 request, and posting a request for output production message to an agent
14 associated with a downstream process if said input stack lacks adequate resources
15 to satisfy said output production request; and,

16 passing to an agent associated with an upstream process any output in said
17 output stack produced in response to said discrete event.

1 11. The method according to claim 10, wherein said causing step further
2 comprises the steps of:

3 identifying a minimum output level of output in an output stack
4 corresponding to a process; and,

5 producing replacement output in response to said output falling below said
6 minimum output level.

1 12. The method according to claim 8, wherein said causing step comprises the
2 steps of:

3 in response to said clock tick event, comparing said clock tick event with a
4 pre-specified takt time corresponding to said associated process; and,

5 in response to a clock tick event correlating to said pre-specified takt time,
6 placing completed output in an output stack corresponding to said associated
7 process, retrieving resources contained in an input stack corresponding to said
8 associated process, initiating production of output using resources contained in said
9 input stack, and passing to an agent associated with an upstream process any
10 output in said output stack.

11 13. A computer apparatus programmed with a routine set of instructions stored
12 in a fixed medium, the computer apparatus comprising:

13 means for receiving a message from an agent;

14 means for identifying in said received message a discrete event selected from
15 the group consisting of a clock tick event, a resources received event, and a
16 request for output production event;

17 means for causing an associated process to perform an activity in response
18 to said identified event; and,

19 means for messaging an adjacent agent in response to said identified event.

20 14. The computer apparatus according to claim 13, wherein said causing means
21 comprises:

22 in response to said clock tick event, means for placing finished output in an
23 output stack corresponding to said associated process;

5 in response to said resources received event, means for initiating production
 6 of output using resources contained in an input stack corresponding to said
 7 associated process; and,

8 means for passing to an agent associated with an upstream process any
 9 output in said output stack produced in response to said discrete event.

1 15. The computer apparatus according to claim 13, wherein said causing means
 2 comprises:

3 in response to said clock tick event, means for placing finished output in an
 4 output stack corresponding to said associated process;

5 in response to said resources received event, means for inspecting an input
 6 stack corresponding to said associated process, and initiating production of output
 7 if said input stack has resources adequate to completely produce an output unit;

8 in response to said request for output production event, means for inspecting
 9 an output stack corresponding to said associated process for adequate output to
 10 satisfy said output production request, inspecting an input stack corresponding to
 11 said associated process only if said output stack lacks adequate output to satisfy
 12 said output production request, initiating production of output if said input stack
 13 has resources adequate to completely produce output sufficient to satisfy said
 14 output request, and posting a request for output production message to an agent
 15 associated with a downstream process if said input stack lacks adequate resources
 16 to satisfy said output production request; and,

17 means for passing to an agent associated with an upstream process any
 18 output in said output stack produced in response to said discrete event.

1 16. The computer apparatus according to claim 15, wherein said causing means
 2 further comprises:

3 means for identifying a minimum output level of output in an output stack

4 corresponding to a process; and,

5 means for producing replacement output in response to said output falling
6 below said minimum output level.

1 17. The method according to claim 13, wherein said causing means comprises
2 the steps of:

3 in response to said clock tick event, means for comparing said clock tick
4 event with a pre-specified takt time corresponding to said associated process; and,

5 in response to a clock tick event correlating to said pre-specified takt time,
6 means for placing completed output in an output stack corresponding to said
7 associated process, retrieving resources contained in an input stack corresponding
8 to said associated process, initiating production of output using resources contained
9 in said input stack, and passing to an agent associated with an upstream process
10 any output in said output stack.